NASA TECH BRIEF

Lightweight Aluminum Casting Alloy Is Useful At Cryogenic Temperatures

The problem: To develop a lightweight, high-strength aluminum casting alloy for use at cryogenic temperatures.

The solution: M-45, a high-purity aluminum casting alloy containing copper and magnesium.

How it's done: The optimum composition of the alloy lies within the following limits:

Element	*Percentage*
Copper	3.90–4.50
Magnesium	0.06–0.10
Cadmium	0.08–0.12
Titanium	0.02–0.05
Others (Si, Fe, Cr, Zn, V)	0.029 maximum
Aluminum	Remainder

Copper and magnesium are primary strengthening additives, and cadmium is an auxiliary strengthener. The effect of cadmium is further enhanced by the addition of titanium, zinc, and chromium. The alloy is prepared from high-purity aluminum, and contamination during melting and casting are avoided to maintain the iron content below 0.02%, as this element reduces the alloy's effectiveness at low temperatures. The tensile and yield strengths and elongation of the alloy increase as its temperature decreases to −423°F (temperature of liquid hydrogen), as shown in the following table of mechanical properties.

Temp. (°F)	Ultimate Tensile Strength (psi)	Yield Strength (psi)	Elongation (%)	V-Notch Charpy (ft-lb)	Ultimate Tensile Strength, Welded Condition* (psi)
80	47,700	44,700	5.0	13.6	36,200
−100	49,600	47,600	4.3		37,700
−200	50,900	47,700	5.1		38,500
−320	56,600	52,400	6.4	18.6	43,500
−423	70,600	56,900	9.4	25.5	49,400

*Welded to 2219-T87 plate, automatic TIG process with 2319 filler wire (one pass).

Notes:

1. The tensile properties of M-45 at cryogenic temperatures are markedly superior to those of other commercial aluminum alloys.
2. This lightweight (density, 0.1 lb/cu in.), high-strength alloy is recommended for the fabrication of structural components and processing equipment which must be serviceable at very low temperatures.
3. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama, 35812
   Reference: B65-10092

Patent status: NASA encourages the immediate commercial use of this invention. Inquiries about obtaining rights for its commercial use may be made to NASA, Code AGP, Washington, D.C., 20546.

Source: M-P&VE-M Laboratory
(M-FS-267)

Category 03